# Claims

[c1]     A method for calibrating a well-logging sensor, comprising:

emitting a first signal into a first calibration substance disposed proximate to the sensor;

measuring a first sensor response from the first signal;

emitting a second signal into a second calibration substance disposed proximate to the sensor;

measuring a second sensor response from the second signal; and

determining a sensor response function from the first sensor response and the second sensor response.

[c2]     The method of claim 1, wherein the sensor response function is a linear function.

[c3]     The method of claim 1, wherein the well-logging sensor is a density sensor.

[c4]     The method of claim 3, wherein one of the first calibration substance and the second calibration substance is an aluminum alloy.

[c5]     The method of claim 3, wherein one of the first calibration substance and the second calibration substance is a magnesium alloy.

[c6]     The method of claim 1, wherein the well-logging sensor is a neutron sensor.

[c7]     The method of claim 6, wherein the neutron sensor is surrounded by water and the first and second calibration substances are disposed in a channel within the neutron sensor.

[c8]     The method of claim 7, wherein one of the first calibration substance and the second calibration substance is air.

[c9]     The method of claim 7, wherein one of the first calibration substance and the second calibration substance is a polymer rod having a known effective porosity.

[c10]     The method of claim 1, further comprising:

determining an expected range for a quality check response of a quality-check

substance;

emitting a quality check signal into the quality-check substance disposed proximate to the sensor;

measuring the quality check response from the quality check signal and comparing the expected range with the quality check response.

[c11]     The method of claim 10, wherein the quality-check substance is water.

[c12]     A method for calibrating a well-logging sensor, comprising:

emitting a first signal into a first calibration substance disposed proximate to the sensor;

measuring a first sensor response from the first signal;

emitting a second signal into a second calibration substance disposed proximate to the sensor;

measuring a second sensor response from the second signal; and

emitting a third signal into a third calibration substance disposed proximate to the sensor;

measuring a third sensor response from the third signal; and

determining a sensor response function from the first sensor response, the second sensor response, and the third sensor response.

[c13]     A method for calibrating a well-logging sensor, comprising:

providing a well-logging sensor having a known response function;

determining an expected range of a quality check response of the sensor using a quality-check substance with known properties;

emitting a quality check signal into the quality-check substance disposed proximate to the sensor;

measuring the quality check response from the quality check signal; and

comparing the expected range with the quality check response.

[c14]     The method of claim 13, wherein the sensor is calibrated using at least one calibration substance, and the quality-check substance is different from the at least one calibration substance.

[c15]     The method of claim 14, wherein the quality-check substance is water.

[c16]     A method for calibrating a well-logging density sensor, comprising:

emitting a first gamma ray signal into an aluminum alloy block disposed proximate to the sensor;

measuring a first density sensor response from the first gamma ray signal;

emitting a second gamma ray signal into a magnesium alloy block disposed proximate to the sensor;

measuring a second density sensor response from the second gamma ray signal; and

determining a density sensor response function from the first density sensor response and the second density sensor response.

[c17]     The method of claim 16, wherein the density sensor response function is linear.

[c18]     The method of claim 16, further comprising:

determining an expected range for a quality check response using water as a quality-check substance from the density response function;

emitting a quality check gamma ray signal into the water disposed proximate to the density sensor;

measuring the quality check response from the quality check gamma ray signal; and

comparing the expected range of the quality check response with the quality check response.

[c19]

A method for calibrating a well-logging density sensor, comprising:

emitting a first gamma ray signal into an aluminum alloy block disposed proximate to the sensor;

measuring a first density sensor response from the first gamma ray signal;

emitting a second gamma ray signal into a magnesium alloy block disposed proximate to the sensor;

measuring a second density sensor response from the second gamma ray signal;

emitting a third gamma ray signal into water disposed proximate to the sensor;

measuring a third density sensor response from the third gamma ray signal; and

determining a density sensor response function from the first density sensor response, the second density sensor response, and the third density sensor response.

[c20]     A method for calibrating a well-logging neutron sensor, comprising:
emitting a first neutron signal with air disposed in a channel within the sensor;
measuring a first neutron sensor response from the first neutron signal;
emitting a second neutron signal with a polymer rod disposed in the sensor channel;
measuring a second neutron sensor response based on the second neutron signal; and
determining a neutron sensor response function from the first neutron sensor response and the second neutron sensor response.

[c21]     The method of claim 20, wherein the neutron sensor response function is linear.

[c22]     The method of claim 20, further comprising:
determining an expected range for a quality check response from the neutron sensor response function;
emitting a quality check neutron signal with water in the sensor channel;
measuring the quality check response from the quality-check signal; and
comparing the expected range of the quality check response with the quality check response.

[c23]     A method for calibrating a well-logging neutron sensor, comprising:
emitting a first neutron signal with air disposed in a channel within the sensor;
measuring a first neutron sensor response from the first neutron signal;
emitting a second neutron signal with a polymer rod disposed in the sensor channel;
measuring a second neutron sensor response based on the second neutron signal; and
emitting a third neutron signal with water disposed in the sensor channel;
measuring a third neutron sensor response based on the third neutron signal; and
determining a neutron sensor response function from the first neutron sensor

response and the third neutron sensor response.

[c24]    A method of calibrating a well-logging sensor, comprising:

emitting a signal into each of at least two calibration substances disposed proximate to the sensor;

measuring at least two sensor responses corresponding to the signals emitted into said disposed calibration substances; and

determining a sensor response function from the at least two sensor responses.